REDUCING HERBICIDE IN BANANA CROPPING SYSTEMS BY INTEGRATING COVER CROPS: EXPERIMENTAL AND MODELLING APPROACH

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Banana cropping systems for export market based on monocropping systems (*Musa* spp., AAA group) and on the massive used of fertilizer and pesticides may present important threats for the environment. In Martinique (French West Indies) there is actually an important demand from society and policy-maker for more sustainable and environmentally friendly banana systems. Nowadays, the reintroduction of fallow and the use of in vitro plantlets constitute effective cultural strategies to reduce nematodes damages and nematicide uses (picture 1). Herbicide use becomes the most important pesticide input in banana farms and developing herbicide free alternatives is a priority. Intercropping with cover crops constitute the main alternative to reduce herbicide used in banana fields, the competition between the banana plant and the cover crop has to be evaluated and eventually compensated.

Picture 1: Banana farm with fallow rotations

Material and methods

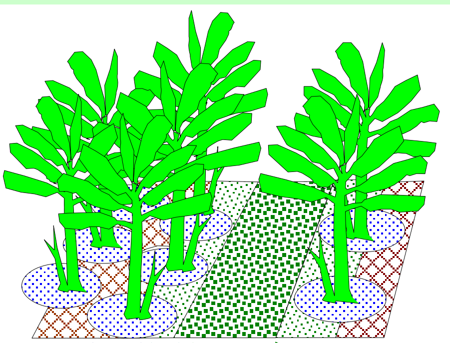
Field experiment

Banana was intercropped with two grass covers in a double row planting design (figure1, picture 2) :
- T0 banana on bare soil obtain by glyphosate spraying,
- T1 with *Cynodon daclylon* mechanically managed
- T2 with *Bracharia decumbens*, mechanically managed.

Nitrogen fertilization 200UN/ha at the 1st cycle and 300UN/ha for the 2nd cycle localized around the banana stem base.
Banana growth and yield component was recorded. Cover crops biomass growth and nitrogen content was measured.
Mineral nitrogen content in soil and chlorophyll meter index (Minolta SPAD 502) of the 2nd leave a nitrogen indicator of banana plants (Dorel et al, 2008 ; Achard and Dorel 2006) was monitored.

Modelling approach

The nitrogen balance model SIMBA-N for banana crop (Dorel, 2008) was adapted to a double row planting design and to account different spatial functioning due to the bananas (shade, water stem flow, roots distribution, crop residue), the competition with the living cover crop (crop demand) and the nitrogen fertilizer localization (figure 1). The cover crop growth simulation integrate the shade of bananas and nitrogen critical curve response.



Zone of homogenous functioning	Zone 1 Small Inter-raw	Zone 2 Stem base	Zone 3 Inter-row border	Zone 4 Large Inter-row
Shade	High	High	Medium	Low
Water flows	Low leach	High/Stem flow	Low leach	Medium
Nitrogen input	Crop residue	Fertilizer	Cover residue	Cover residue
N demand	Banana	Banana+Grass	Banana+Grass	Grass > Banana
% total area	10%	23%	19%	48%

Fig. 1: Spatial functioning of banana intercropped with cover crop

Picture 2: Experimental plots with banana and *Bracharia decumbens* intercropped

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Results and discussion

Agronomic results on bananas show for the intercropped plots versus bare soil (table 1):
- Very similar impact for the two cover species,
- During the first cycle, nitrogen limitation, inducing lower growth, lighter bunch and longer crop cycle,
- No growth and yield impact during the second cycle, and no additional impact on crop duration.

Table 1: Agronomic result of intercropping experiment on bananas and grass cover crops

Agronomic parameter	Vegetative growth (12& 52 weeks after planting)		Growth at flowering		Cycle duration	Bunch size
Cycle /Treatment	Pseudostem high (cm)	Chlorophyll index SPAD	Pseudostem high (cm)	Chlorophyl index SPAD	WAP (weeks)	Finger number
First Cycle						
T0 Bare soil	180 A	57 A	264	55	26 A	171 A
T1 Cynodon cover	135 B	53 B	262	55	32 B	156 B
T2 Bracharia cover	120 B	52 B	271	57	34 B	164 AB
Statistics	HS	HS	NS	NS	S	S
Second cycle						
T0 Bare soil	262 A	55	296	56 B	62 A	216
T1 Cynodon cover	203 B	53	302	58 A	69 B	218
T2 Bracharia cover	213 B	53	301	56 B	69 B	213
Statistics	HS	NS	NS	S	HS	NS

The model simulation highlight that nitrogen competition is clearly link to the cover crop growth and its nitrogen demand during establishment: 9 and 5 t dry matter/3 months, corresponding to 110 and 55 UN/ha for *Bracharia decumbens* and *Cynodon daclylon* respectively (Figure 2).
After establishment, nitrogen return by mineralization of cover crops residues provide more equilibrate the nitrogen balance similarly to Brachiaria pasture (Boddey, 2004).

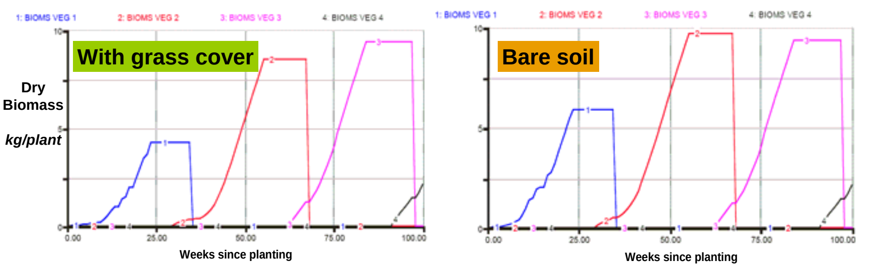

Fig. 2: Growth simulation of bananas of successive cropping cycles, with grass cover (left) and on bare soil (on the right)

Different options to obtain low yield impact of intercropping cover crops could be simulate:
- Increasing nitrogen fertilization during the cover crop establishment (from 45 to 145 UN/ha),
- Delay banana planting after the establishment of the cover crop (photo 2),
- Using cover crops with lower nitrogen need.

Conclusion

An experimental agronomic evaluation of intercropping bananas with cover crops shows nitrogen competition between banana and cover crops especially during establishment. Modelling the spatial functioning is relevant for simulating intercropping systems, for the optimization.

Future activities will deal with introducing legume cover as cover crop and with a more comprehensive evaluation of agronomic and environmental performances of these new banana cropping systems.

References

Achard R., Dorel M., 2006. Chlorophyll meter reference curve for nitrogen fertilizer management during vegetative banana growth in French West Indies. Congress European Society of Agronomy, Warsow, Poland, 4-7/09/2006.

Dorel, M., Achard, R., Tixier, P., 2008. SIMBA-N: modelling nitrogen dynamics in banana populations in wet tropical climate. Application to fertilization management in the Caribbean. European Journal of Agronomy, 29, 38-45.

Boddey R.M., Macedob R., Tarré R.M., Ferreira E., de Oliveira O.C., de P. Rezende C., Cantarutti R.B., Pereira J.M. and Urquiaga S. 2004. Nitrogen cycling in Brachiaria pastures: the key to understanding the process of pasture decline. Agriculture, Ecosystems and Environment 103 (2004) 389–403.